Space Communications Technology Link

A publication which reports upon the news and events of the Space Communications Program
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Changing the way NASA and the Nation Communicate through Space

Glenn Research Center FY00 Technology Products for High Rate Data Delivery

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As part of a new Cross Enterprise Technology Development Program (CETDP) process, the Space Communications Program (SCP) successfully proposed and has been approved for FY00 funding for 13 technology product development tasks. This new funding process is just one of the many changes that has occurred in the CETDP. Of the 17 proposals originally submitted to the CETDP High Rate Data Delivery (HRDD) Thrust Area, 13 were accepted for funding after being determined to be highly relevant to NASA's Earth Science (ES), Space Science (SS), and Human Exploration and Development of Space (HEDS) Enterprises by a non-advocate review (NAR) team.

The technology development product proposals submitted represent a cross-section of the communications technology developed by the CTD. The diversity of technology products proposed ranges from software to hardware, digital to analog, and components to subsystems, all from Technology Readiness Level (TRL) 1 to 4. Several proposals contain significant leveraging through intra-agency, academia, and industry partnerships. The duration of the technology product developments ranges from one to three years. A brief description of each of the technology product development tasks and their major deliverables follows:

SiGe Radio Frequency Solid State Power Amplifier

Development of SiGe device technology to enable low cost, lightweight, communications systems. This effort is a collaboration between GRC, JPL, and the University of Michigan to develop SiGe Heterojunction Bipolar Transistors (HBT) and passive circuit elements on silicon substrates. This goals of this task are to produce a five-watt, X-band, monolithic SiGe HBT and Ka-band SiGe power transistors.

Ferroelectric Tunable Microwave Circuits and Subsystems

Development of ferroelectric-based tunable microwave components to create an entirely new class of versatile, low loss, low cost, and compact microwave components for NASA's near-Earth and deep space communications and remote sensing applications. In particular, this task will culminate with the demonstration of a proof-of-concept, electronically scanned reflectarray antenna which promises orders of magnitude cost reduction over state-of-the-art MMIC-based phased array antennas.

Low Loss, Miniature Components for System on a Chip and Phased Array Antennas

Development of microwave MEMS devices integrated with miniature microwave transmission lines and components to enable low loss RF distribution networks required for highly-integrated, miniature microwave communications systems necessary for pico/nano sciencecraft and micro-rovers. In addition to the development of multilayer processing techniques, this collaborative effort between GRC, JPL, and the University of Michigan will model and fabricate microwave MEMS components for demonstration in a Ka-band phased array antenna.

High Rate Modulation Using Orthogonal Frequency Division Multiplexing (OFDM)

Development of an innovative modem architecture that will enable data rates beyond 1 Gbps for near-Earth (or near-

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An in-depth look into our publication:

On our Cover

Technology Products for High Rate Data Delivery

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(Technology Products continued.)

planet) data return links. The targeted modem architecture utilizes a multi-channel, OFDM technique in which several relatively low-speed parallel channels are combined to form a higher data rate modem. The goal of this task is to use four, 155 Mbps channels to produce a composite 622 Mbps modem.

Transport Protocols for Space-Based Internets

Development of efficient and reliable Internet protocols to enable NASA spacecraft to realize space-based Internet communications for easy access to global Earth Science mission data, interactive communication with the ISS, and interconnection with the future Mars-based communications infrastructure. Through this task commercial Internet communications protocols will be modified and characterized to enable space-based IP and mobile-IP protocols.

Cryogenic Receiver Terminal

Development of a 19 GHz, ground terminal-based, tracking, cryogenic receiver to support the Direct Data Distribution (D3) technology demonstration experiment. The terminal will consist of a specially designed Cassegrain reflector, a six-pole High Temperature Superconductor (HTS) microstrip bandpass filter, a three-stage MMIC amplifier, and a 1-watt Stirling-cycle cryocooler. The anticipated performance of the terminal is expected to enable a factor of four reduction in required communications link signal.

High Rate, Radiation-Hardened Digital Modem

Development of a high data rate, bandwidth efficient, radiation-hardened, digital modulator Application Specific Integrated Circuit (ASIC) with programmable modulation and coding to support near-Earth, high data rate data return from NASA spacecraft. In collaboration with Sandia National Laboratories, GRC will fabricate and characterize a 155 Mbps radiation-hardened modem which is targeted for a National Polar Orbiting

Note Correction:

Reference to article #2299-04 titled "Experimenting Spacecraft Control via the Internet", in the Volume 2, Number 2, Spring issue of SCTL, it was stated that the significance of the GSFC OMNI experiment was that it demonstrated, for the first time, end-to-end control of devices through the Internet and TDRSS. This step, albeit at a low data rate is a precursor of the requirement to communicate with all spacecraft in this manner. Correction: The significance of the GSFC OMNI experiment was that it demonstrated, for the first time, end-to-end control of "remote" devices through the Internet and TDRSS.

Environmental Satellite System (NPOESS) follow-on technology demonstration.

Simulation and Design Optimization of Traveling-Wave Tubes
Development of simulation and design tools for accelerating the development of TWTs to enable very long baseline interferometry data return and interplanetary microwave communications links. The focus of this task will be to develop a 100W Ka-band TWT design that is both efficient and highly reliable. The design tools development will enable accurate and efficient modeling of TWT sub-elements, reducing the design time by a factor of ten.

MEMS Actuator-Based Re-configurable Antenna Technology
Development of lightweight, miniature, phased array antennas using MEMS-based actuators to re-configure the electrical properties of the antenna elements and dynamically modify the antenna's performance. Low mass, miniature, phased array antennas are a key element of communications systems for several near-Earth and planetary platforms such as balloons, airplanes, buoys, and rovers. Leveraging the established MEMS technology, this task will target demonstrating an actuator-based, four-element subarray.

Advanced Routing and Integrated Onboard Processing
Development of a miniaturized, integrated onboard network module that will enable NASA space platforms and instruments on those platforms to be nodes on the Space Internet. The envisioned network module will combine the features of routing, protocol translation, encoding/decoding, encryption/decryption, heath monitoring, and synchronization. The development of such a network module is critical to enable the functionality required to realize the Space Internet.

In-Space Internet Technologies for NASA Enterprises' Revolutionary Communications Concepts
Development of network architecture simulations that accurately model advanced communications networks linking NASA spacecraft and ground segments, along with the development of a network emulation testbed to verify optimal candidate network architectures in hardware implementation. The goal of this task will be to accurately simulate and emulate single-node and multi-node network architectures that will enable NASA spacecraft to fully realize the benefits of the Space Internet for both manned and unmanned NASA missions, and further enable spacecraft constellations for distributed spacecraft operations.

K-Band Scanning Phased Array Antenna
Development of a 19 GHz transmit, MMIC-based phased array antenna capable of supporting two, independent communications links between a LEO spacecraft and a tracking ground terminal at data return rates up to 1.2 Gbps. This collaborative effort between GRC and Raytheon Systems Company will deliver a proto-flight antenna for integration into GRC's Direct Data Distribution (D3), STS technology demonstration experiment. This technology development will enable NASA spacecraft to leverage the future commercial communications infrastructure planned for implementation in the next few years.

High Performance Printed Antennas
Development of low-cost, lightweight, printed antennas for near-Earth and planetary microwave communications systems. The focus of this task will be to develop high performance printed antennas for NASA science platforms such as balloons, remotely piloted vehicles, rovers, as well as in-situ platforms such as ocean buoys, enabling them to establish data return and command and control communications links. Key performance parameters to be optimized are gain, bandwidth, impedance, and loss, in prototype implementations.

In the new model of the CETDP, each of these tasks will be evaluated on a regular basis for performance against milestones and customer needs. The goal is to better focus NASA's technology development funds on specific, targeted deliverables that will enable NASA's missions, while at the same time harnessing the creativity of NASA's technology research core competence. This is clearly a difficult task, but one for which the SCP has risen to the challenge.

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and refer to Article: 2399-01

Cleveland Ranked Second in Nation for Recreation

A publication that rates the best places to live nationwide says the Cleveland area is number two in the Nation in terms of recreational opportunities, outranked only by New Orleans.

The ranking comes from the "Places Rated Almanac," which ranks all of the Nation's metropolitan areas statistically.

The criteria in the recreation category are the availability of amusement and theme parks, aquariums, auto racing, college sports, gambling, golf courses, good restaurants, movie theaters, professional sports, wildlife areas, skiing, water areas and zoos.

Visit Cleveland in Y2K at the Sixth Ka-Band Utilization Conference, May 31-June 2, 2000

The Use of Spaceborne Passive Remote Sensors and Their Radio Spectrum Frequency Needs

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What is a "passive sensor"? A passive sensor is a microwave instrument designed to receive and to measure natural emissions produced by the Earth's surface and its atmosphere. The frequency and strength of these natural emissions characterize the type and the status of a large number of important geophysical, atmospheric and surface parameters of the land, sea, and ice caps, that describe the status of the Earth system (i.e., The Earth, its atmosphere, and the oceans) and its mechanisms.

Earth surface parameters that can be measured or assessed by passive microwave techniques include soil moisture content, sea surface temperature, ocean wind stress, ice extension and age, snow cover, and rainfall over land among others. Three-dimensional atmospheric parameters (i.e., low, medium, and upper atmosphere) that can be measured or detected in particular are atmospheric temperature profiles, water vapor content, and concentration profiles of radiatively and chemically important trace gases (e.g., ozone, nitrous oxide, carbon monoxide, hydrogen nitrate, and various chlorides).

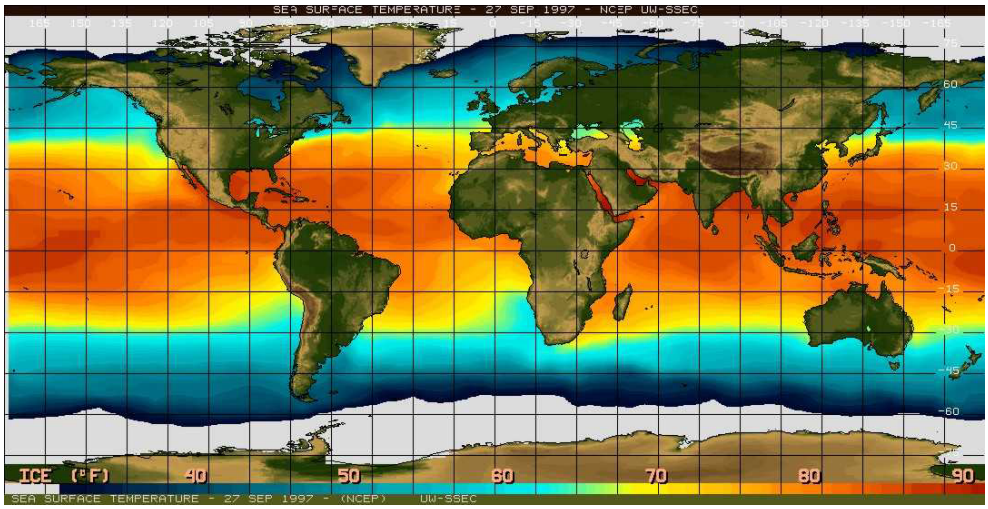
Several geophysical parameters may contribute at varying levels to the natural emission that can be observed at a given frequency. Therefore, several frequencies in the microwave spectrum must be measured simultaneously in order to isolate and to retrieve each individual contribution. For example, in the case of measurements over ocean surfaces, measurements around 6 GHz offer the best sensitivity to sea surface temperature, but contain a small contribution due to salinity and wind speed which can be removed using measurements around 1.4 GHz and around 10 GHz where response to one or the other of these is minimal. The 17-19 GHz region, where the natural emissions related to sea surface temperature and atmospheric water vapour are the smallest, is optimum for ocean surface emissivity. This emissivity is directly linked to the wind speed near the surface, or to the presence of sea ice, but also has some sensitivity to total water vapor content and to liquid clouds. Total content of water vapour can be best measured around 23 GHz, while liquid clouds are obtained via measurements around 36 GHz. Therefore, simultaneous measurements of natural microwave radiation at several frequencies are required to discriminate between the number of geophysical parameters which contribute in varying degrees to each of them.

Passive microwave sensing is an important tool widely used for meteorological, climatological, and environmental monitoring and survey (both operational and scientific applications), for which reliable repetitive global coverage is mandatory

Spaceborne passive sensors enable the global observation of the Earth's surface and its atmosphere from a satellite's orbit even in the presence of clouds, which are almost transparent at most microwave wavelengths of interest to remote sensing scientists. Indeed, passive microwave sensing is an important tool widely used for meteorological, climatological, and environmental monitoring and survey (both operational and scientific applications), for which reliable repetitive global coverage is mandatory.

The nature of remote passive microwave sensing of the Earth requires measurement of very small changes in the ambient microwave radiation in the sensor's field of view. This is accomplished using microwave radiometers which are highly sensitive receivers capable of measuring low levels of microwave radiation. Passive microwave sensors integrate all natural (wanted) and man-made (unwanted) emissions. They cannot differentiate between these two kinds of signals. They are therefore extremely vulnerable to radiated interference. Due to these factors, it is very difficult, if not impossible, for passive microwave sensors to share spectrum with most active services.

Most of the frequencies used by passive sensors were allocated to the Earth Exploration-Satellite Service (passive) at the 1979 World Administrative Radio Conference (WARC-79). Although there was significant information available on passive sensing requirements at frequencies below 50 GHz, the spectrum requirements above 50 GHz were not as well known. Subsequently, the 1997 World Radiocommunication Conference (WRC-97) realigned the spectrum between 50 GHz and 71 GHz in part to provide protection to important passive remote sensing requirements in this frequency range. At the 2000 WRC, delegates will deal with the important agenda item on passive allocations from 71 GHz to 275 GHz and beyond, that hopefully will provide protection to important passive microwave sensing requirements in this frequency range that include 86-92 GHz, around 101 GHz, around 110 GHz, large bands around 118 and 183 GHz needed for atmospheric measurements key to weather prediction, around 150 GHz and 165 GHz, 200-209 GHz, around 228 GHz, and around 236 and 251 GHz.



Composite representation of the sea surface temperature for September 27, 1997 as measured by the Special Sensor Microwave/Image (SSM/I) instrument.

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Global Positioning Systems (GPS)

Applications

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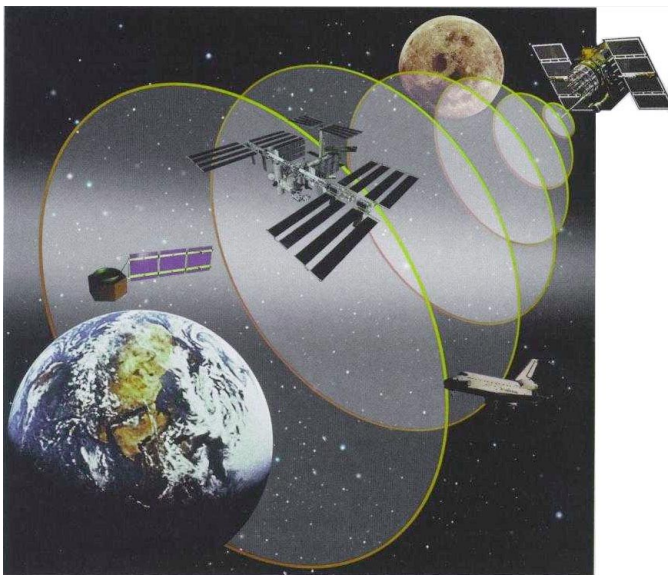
In the Space Communications Technology Link Issue Volume 2, No. 1 we looked at why we need to protect the Radio Spectrum supporting the Global Positioning System (GPS) and talked at length about What is Satellite Navigation. In Volume 2, No. 2 we answered the question What is Satellite Navigation. In the following issues we intend to discuss Specific Application Uses of GPS. As we discuss these topics, I would encourage the readers to let us know of specific applications or uses of GPS either domestic or international that we do not mention or cover.

Space

The diminishing budgets for space projects require new and more efficient ways of doing business. Aerospace professionals in both the private and government sectors are being increasingly challenged to find new more efficient ways to launch fleets of smaller, more capable satellites. The traditional methods of space navigation and tracking are proving to be a major expense in space programs. Future ground stations will be more automated and operate with less manual intensive ground stations. More innovative and less expensive solutions must be found if space is to be economically exploited for the benefit of all nations.

GPS is helping to revolutionize and revitalize the way nations operate in space-from guidance systems for the International Space Station's crew return vehicle to the management, tracking, and control of communication satellite constellations. Satellite navigation in space, the process of planning and controlling a satellite's orbit has radically changed with the advent of GPS. Using traditional navigation methods, ground crews remotely control the orbit of a satellite using time and money-intensive tracking procedures from ground stations around the world.



GPS is helping to revolutionize the way nations operate in space.

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(GPS Applications continued.)

stations simpler and requiring fewer operators. And, by incorporating other GPS features such as on-board maneuver planning and autonomous constellation control, a single operations crew in a single ground station will be able to manage fleets of satellites in constellations around the earth.

A future GPS enhancement known as cross link ranging, will allow a spacecraft's GPS receiver to retransmit GPS signals to nearby spacecraft enabling them to determine their positions relative to one another. By combining a cross-link system with on-board maneuver planning and navigation software, space vehicles will be able to fly in a formation with one vehicle autonomously controlling the geometric pattern of the entire constellation.

Space vehicle designers are incorporating GPS-augmented inertial navigation packages for the International Space Station. Even the Emergency Crew Return Vehicle will take advantage of GPS as the primary source of guidance information. Future booster rockets and reusable launch vehicles will launch, orbit the earth, return and land, all under automatic control using guidance provided by GPS.

Benefits to Users

- Navigation solutions-providing high precision navigation services and minimum ground crews with existing space-qualified GPS units.
- Course attitude solutions replacing high cost on-board attitude sensors.
- Timing solutions-replacing expensive spacecraft atomic clocks with low-cost, precise-time GPS receivers.
- Constellation control-providing single point-of-contact to control for the orbit maintenance of large numbers of space vehicles such as telecommunication satellites.
- Formation flying-allowing precision satellite formations with minimal intervention from ground crews.
- Level of precision enables quick measurements of ocean heights

Public Safety

Space based navigation is rapidly becoming an integral part of the world's modern emergency response systems – whether helping stranded motorists find assistance, or guiding speeding ambulance and fire rescue vehicles to a crash site. Soon, automobiles, boats and planes equipped with autonomous crash sensors and GPS systems will be able to "Call for Help" even when its occupants are unable to do so.

Vehicle accidents in rural areas account for a dis-proportionate share of all fatalities. This is due in large part to the time it takes for someone to notice the accident site, find a suitable way to report it to authorities, and provide accurate and reliable information to emergency response personnel. Whether it is a fire, an automobile, boating or plane accident, or a snow blocked road, public safety managers need to have accurate and timely information about problem sites – most importantly its location, type of accident or obstruction and nature of injuries. This includes much more than ambulances and fire trucks. Transportation managers and emergency service providers need to know the location of everything from helicopters to snow plows to save lives and to ensure the nation's transportation system functions safely and efficiently.

A critical component of any successful rescue operation is time, and knowing the precise location of an accident or emergency event reduces that time and saves lives. Currently many emergency response systems must rely on inaccurate or sketchy information to formulate their response strategy. Accurate location information about the accident site, nature and type of accident as well as the emergency vehicles marshaled to respond to it are critical to safety of life and property loss reduction.

The Global Positioning System (GPS) is fast becoming an industry standard in many nations for use by emergency and other specialty vehicle fleets. Location and status information provided by the GPS input to public safety systems is a "breakthrough" technology which offers managers a quantum leap forward in efficient operation of their emergency response teams. The ability to effectively identify and view the location of police, fire, rescue, and individual boats or vehicles, and how their location relates to an entire network of transportation systems in a geographic area, means a whole new way of doing business.

Space based navigation is rapidly becoming an integral part of emergency response teams.

The tasks associated with accepting calls and the complexity of routing response vehicles can be vastly simplified using GPS. In rural areas where vast amounts of open land areas are involved and time is critical, GPS literally saves lives. Positive location information provided by GPS coupled with automation, means that emergency control personnel may no longer have to struggle manually to match response vehicles with people in distress.

The widespread placement of GPS location systems in passenger cars will provide another leap forward in developing a comprehensive safety net for individual travelers. Too often, when people need help the most, they are in no position to call for it. Even if they could call for help, they are often too disoriented or traumatized to provide useful information about their location – the key piece of emergency information. In outfitting individual passenger vehicles with GPS systems and wireless communications, the safety net becomes complete by having information about the nature and location of problems and the location of assets to solve those problems.

In the future, when GPS location information becomes coupled with network traffic management systems, fleet monitoring systems, weather information systems, and in-vehicle autonomous crash detection systems, a whole new class of public safety capability will emerge. In a future scenario, an unwitnessed crash, which occurs in the middle of the night in a rural area served by only a few roads, will be handled significantly different than it might be today. The crash sensor will send a message to the emergency center that the crash has occurred along with the precise location and position of the accident. Additional information the message may contain would be the type of vehicle, presence of airbags and if they were deployed. The emergency center will use this information to determine whether this is a serious crash requiring immediate transport to high level medical facility. Because the system will be tied into traffic and weather information systems, emergency personnel will know the conditions of all roads and airspace leading to the accident site. They will also know the location and status of fire rescue and medical evacuation helicopter fleets and be able to dispatch the right assets to the precise location of the crash. All of this will occur within 2 minutes of the crash event, a process that by today's standards might take hours and sometimes even days depending on the remoteness of the location.

Benefits to the user

- Shorter response times to site of emergency.
- Quicker transportation of the injured to emergency relief facilities.
- Improved asset management and dispatching.
- Quicker restoration of normal transportation operation.
- Reduction in property loss.

The GPS applications that will be covered in the next issue of the SCTL are Aviation and Timing. The following is a brief overview of those subjects

Aviation

Space based navigation has become the acknowledged navigation system of the future for all nations, providing three-dimensional guidance and surveillance for oceanic, en route, terminal, airport surface, non precision approach operations worldwide.

Timing

Global Positioning System (GPS) signals from approximately eleven thousand miles above the earth provide a valuable fourth dimension—precise time. This universally available service is improving and changing the way many businesses accurately track, manage, and synchronize their operations. Precise timing, made available through GPS, is playing an ever increasingly role in the expansion of time-critical applications on a global basis.

Other application, will be presented in future publications are: Agriculture, Maritime, Environmental, Rail Surface, Recreation and Surveying.

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and refer to Article: 2399-03

The Arctic Mars Project

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A highly portable Ka-Band ground terminal was used with ACTS in the unique and harsh environment of the Arctic in July 1999. The terminal is part of the continuing development, fabrication and testing of small terminals and mobile tracking antenna by the United States Air Force Research Laboratory (AFRL) and the Canadian Research Center (CRC). Key participants included NASA Ames Research Center (ARC) and Simon Frasier University.

Sometimes referred to the Haughton Expedition or as the Arctic-Mars Mobile Exploration System Project, its purpose is to develop and test tools for remote planetary science exploration and for understanding requirements for manned exploration such as Mars. Of course, communications technologies will construct the vital links from remote places of conducting science to where the scientists and other resources

(Continued on page 8)

(Arctic Mars Project continued.)

are located allowing probes to be remotely manuevered and data to be interpreted from afar. Furthermore, the technologies used and lessons learned from this project may enable future remote communications infrastructure between multiple probes and rovers or between the members of a NASA exploration team.

The backdrop for this activity was Devon Island, located in the Nunavut region of Canada at 75°22N latitude and 89°41W longitude. The expedition base camp was inside the Haughton impact crater and was chosen due to its resemblance of the Martian landscape. The actual geology, biology, planetary science and environmental science tests that were conducted provided similar types of applications, data and communications requirements that would be needed in a robotic exploration scenario. Furthermore, the real time data collection and dissemination, video teleconferencing, and immersive virtual and tele-operational controls lend itself to the use of Ka-Band systems for higher bandwidth, smaller ground terminals, and interactive human applications. Refer: http://www.arcticmars.org

Voice communications were established via Iridium, TMI Communications and the 106°W MSAT which were used extensively as an order wire. Conventional 56 kbps data communications were established using the Anik E1 spacecraft, operated by Telesat Canada, and a transportable 1.8m C-band ground terminal at the exploration site to a 9m terminal at CRC. The ACTS link was achieved using a highly transportable, 50cm Ka-Band ground terminal at the exploration site primarily developed by CRC and jointly tested by CRC and AFRL back to the 1.8m ground terminal at AFRL in Rome, New York. The ACTS link provided high bandwidth internet connectivity to the Haughton-Mars team from the Devon Island local area network comprising of several computers which became part of a subnet at AFRL specifically established to support the month long project. In this case, the ACTS link created a bridge running at 512 kbps into the AFRL internal network system. RAD Data Communications product Tinybridge, was utilized at each end of the link to provide the Transmission Control Protocol/ Internet Protocol (TCP/IP) connectivity between the AFRL and Devon Island networks with connectivity to SFU via an Asunchronous Transfer Mode (ATM) fiber connection and then to other internet accessible sites. Important daily videoconferencing between the site and NASA Mission Control in Houston via ACTS utilized 10 baseT traffic. In addition to supporting the expedition and applications, this provided a rare opportunity to evaluate the Ka-Band performance with respect to multipath effects, atmospheric ducting, and other extreme look angle phenomena.

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ACTS Experiment #154

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NASA has a vision of making spacecraft and/or space-based instruments nodes on the Internet. This will enhance mission and data services by allowing interactive services for better science while eliminating costly independent infrastructure. To achieve this, NASA is leading an industry consortium that investigates high performance hybrid networks. These investigations address the protocol efficiency of Transport Control Protocol/ Internet Protocol (TCP/IP) including congestion vs. error detection/correction, implementation of frame-based layer 2 protocols such as gigabit Ethernet and packet over Synchronous Optical Network (SONET), and the corresponding effects upon symmetric and asymmetric network applications. The goal is to allow ubiquitous communications across any communications medium and operating platform.

This investigation is focused in Advanced Communications Technology Satellite (ACTS) Experiment #154 which will build upon the technical objectives, collaboration efforts, experiments, results, and conclusions/recommendations of ACTS Experiment #118x in pursuit of realizing the Space Internet vision.

These types of efforts was enabled by the Glenn Research Center who established a partnership with computer, telecommunication, and satellite industries. The experiment promoted the development of interoperability, high-performance TCP/IP implementations across multiple computing/operating programs. Many outstanding questions regarding the use of standard protocols {TCP/IP and Asynchronous Transfer Mode (ATM)} for the delivery of advanced data services, and use in spacecraft architectures were answered. One particular importance of ACTS Experiment 118x was the validation of TCP implementation, which allows hundreds of Mbps (Megabits per second) throughput in an asymmetric scenario as well as establishing a return-to-forward link ration of 200:1 in an asymmetric scenario.

However, there is more work to be done. For instance, the TCP stacks need to be baselined and tested for interoperability will all aspects of TCP exercised including: large windows, fast-retransmit, fast-recovery and (Selective Acknowledgment) SACK. Hence, follow-on experiment activities, like ACTS Experiment 154, are addressing these areas.

Experiment #154 will create a foundation for implementing an Internet in space in the following ways:

- Complete the homogeneous and heterogeneous interoperability test matrix which was established in ACTS Experiment #118x
- Update, expand, and complete the additional test matrix elements including back-to-back benchmark tests and satellite link simulations in the event of ACTS unavailability

- Investigate the relationship between congestion and link error detection/correction, including TCP/IP, Satellite Communications Protocol Standard (SCPS), and protocol implementation and link characteristics considerations
- Investigate the performance of frame-based layer-2 protocols, including Gigabit Ethernet and Packet over SONET, implemented on ATM based and non-ATM based satellite-terrestrial networks
- Investigate network variation effects of asymmetric and symmetric hybrid networks, including considerations of multicast, multi-user access methods, and the demands of various applications

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WINCOMM Flies to AirVenture '99

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Satellite Networks and Architectures Branch,
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Entrance to the AirVenture '99 flight line area.

During July 28 through August 3, 1999, over 765,000 aviation enthusiasts turned out to experience the 47th annual edition of the Experimental Aircraft Association (EAA) AirVenture '99 at Wittman Regional Airport in Oshkosh, WI. Joining them at the world's largest fly-in were members of the aviation Weather Information Communications (WINCOMM) team, Robert J. Kerczewski and Paul G. Mallasch.

The goal of WINCOMM is development of advanced information technologies to enable high quality and timely dissemination of aviation weather information. Specifically, the WINCOMM project addresses communications specific issues associated with dissemination of weather data. The new aeronautical communication technologies developed by WINCOMM will provide the following benefits to the national and global aviation community:

Robert "Buzz" Kerczewski takes the right seat of the NASA 757.

- Affordable, high quality (graphical), and timely weather information for all users to promote safety and efficiency.
- Greater access and connectivity across all users and platforms on the information network, both airborne and ground-based.
- Promotion of an integrated global information network, enabling collaborative decision-making to further enhance aviation safety.

Mr. Kerczewski and Mr. Mallasch shared an exhibit with NASA Langley's Flight Information Services Data Link (FISDL) Safety Booth within NASA's General Aviation hanger. The Aviation Weather Information (AWIN) Project, led by the NASA Langley Research Center, specifically addresses operator support and enhanced weather product research issues. The WINCOMM and AWIN projects are highly integrated due their inherent synergy.

The exhibit drew large crowds and served as an excellent medium to inform pilots, the aviation community, and the attending public about the efforts and progress of the WINCOMM project. Team members enthusiastically received and answered many questions while discussing the future of weather information communications with many members of the flying public. Visit the Experimental Aircraft Association homepage for additional photographs and information on AirVenture '99 Oshkosh at ***http://www.eaa.org***.

Paul Mallasch and Robert Kerczewski at the AWIN / WINCOMM

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Ka-Band Conference is Ready to "Rock" Cleveland in Y2K!

Frank Gargione
ACTS Experiments Office
Analex Corporation

Robert A. Bauer
ACTS Experiments Office
Space Communications Office

The Ka-Band Utilization Conference has been held in Italy every year starting in 1995. It was founded for the purpose of publicizing the results obtained by the Italsat and ACTS satellites, the only satellites operating in the 20/30 GHz frequency band (Ka-Band) at the time. The conference was needed to dispel the myths that Ka-Band was not suitable for communications because signals at these frequencies experience severe attenuation due to rain. The two existing satellites had been designed with margin and fade mitigation techniques that could be invoked to provide reliable communications in periods of rain, but their performance was not known beyond the small circle of initial users of these systems. Since its origin, it has since grown to cover various areas of interest, such as systems, experimental results, propagation and fade mitigation, ground terminals and components, architectures and protocols, marketing and financing, band sharing and interference avoidance. The Conference Proceedings, which include all the papers presented each year, have become the most complete source of technical information about all activities at Ka-Band and provide a permanent record of the advances made in this field of satellite communications.

Next year's Ka-Band Utilization Conference will change its venue from Italy to the United States and is targeted for May 31–June 2, 2000. The Advanced Communications Technology Satellite (ACTS), conceived, implemented and operated by the Glenn Research Center has contributed much of the knowledge gained so far at Ka-Band, and thus it is proper that the conference be held in Cleveland to celebrate the success of ACTS before its decommissioning.

The conference will in fact dedicate a full day of activities to ACTS highlighting its accomplishments, celebrating its contributions to the satellite industry, and providing a gathering place where its promoters, makers and users can get together to reminisce and reacquaint themselves with the program and each other.

The call for papers for the conference is included in this issue of the Space Technology Communications Link to provide its readers with full details of this forthcoming event.

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Sixth Ka-Band Utilization Conference

May 31 – June 2, 2000

Cleveland, Ohio, USA

Announcement and Call for Papers

DEADLINE FOR SUBMISSION OF ABSTRACTS
January 14, 2000

The new millennium is also bringing changes to the Ka-Band Utilization Conference!

The 2000 conference, in fact, will be held in Cleveland, Ohio, USA, from May 31 to June 2, to celebrate with NASA the success of the ACTS program, which is coming to the end of its long and fruitful life after nearly seven years of revolutionary accomplishments.

The move to Cleveland is a fitting tribute to the city that hosts the NASA Glenn Research Center, where ACTS was conceived, managed and operated throughout its life.

The conference will follow a slightly different format for 2000. The entire first day will be dedicated to ACTS. It will start with a number of technical sessions featuring invited papers summarizing the program accomplishments, followed by a presentation of the Glenn Research Center's future activities in satellite communications, and capped in the evening by the ACTS decommissioning ceremony and a cocktail hour to let people reminisce. Dignitaries from NASA, from the companies that built ACTS and from the companies that are launching Ka-Band systems will be invited to participate in the festivities and to express what the ACTS program has meant to them.

In addition to the ACTS activities, the Satellite Communications in the Global Information Infrastructure (SCGII) conference will hold its U.S. meeting in Cleveland, joining the Ka-Band participants as they did in Florence in 1996. The SCGII will hold paper presentations in specific session(s) of the Ka-Band conference in the areas of common interest, followed on Friday afternoon by dedicated SCGII workshops. This is an opportunity for the Ka-Band conference attendees to become acquainted with the work of this group that promotes the presence of high bandwidth satellites in the Global Information Infrastructure!

As in past years, the conference will cover activities in Ka-Band and higher frequencies in the following areas:

- New and Updated Systems
- Experimental Results
- Propagation and Fade Mitigation
- Interoperability
- Band Sharing
- Protocols
- Architectures
- Ground Systems
- Advances in Components
- Financing and Marketing

Organization / Secretariat

Franco Bertoldi
IIC - Istituto Internazionale delle Comunicazioni
Via Pertinace - Villa Piaggio
16125 GENOVA, Italy
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JAPAN / ASIA

Naoto Kadowaki
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Fax: +81 4232 76699
E-mail: naoto@crl.go.jp

Web page for the Conference

http://kaconf.grc.nasa.gov

Important dates

- **January 14, 2000**: Extended abstracts submitted by e-mail to the Secretariat. Word format preferred.
- **February 11, 2000**: Principal author notified of acceptance of abstract by e-mail.
- **April 8, 2000**: Final copy ready papers (up to eight pages, including figures) due to the Secretariat. Electronic submission in Word format preferred.

GENERAL INFORMATION

Conference Location
The conference will be held at the Renaissance Hotel, Tower City Center, 24 Public Square, Cleveland, Ohio,

Registration Fee
Payment received ***before April 30, 2000 Lit. 1.100.000***
Payment received ***after April 30, 2000 Lit. 1.300.000***

Payment
The fee should be paid in Italian Lire as follows:
– ***by bank cheque,*** *payable to* ***Instituto Internazionale delle Comunicazioni****, to be mailed with the enclosed* **Registration Form** *to the Secretariat by IIC*

– **by bank transfer**, free of bank charges, to:
Istituto Internazionale delle Comunicazioni
Account No.10543/80 - Banca CARIGE, Sede Centrale
Bank codes: ABI 06175-4, CAB 01400-1
via Cassa di Risparmio 15, 16123 Genova, Italy

– by credit cards: VISA, Mastercard, Eurocard **(no Amex)**

Cancellation
Registration fee (75%) can be refunded only if notification is given in writing before **April 30.** After this date, fee will not be refunded and the Conference Proceedings will be mailed.

Registration Desk
The Registration and Information Desk will be open in the Conference Hotel on Sunday, May 30 from 17:00 to 19:00 and the following days during the Conference hours.

Proceedings
A copy of the Conference Proceedings will be provided in the Conference kit at the Registration.

Hotel Accommodation
Participants will be accommodated by the Renaissance Cleveland Hotel, site of the Conference, which offers a full range of services and facilities for such an event. The hotel rates and the instructions for payment are indicated in the enclosed **Hotel Booking Form.**

Deadline for Hotel Booking
May 1, 2000

Reservations received after **May 1, 2000** will be accepted if rooms are still available.

• *Renaissance Cleveland Hotel* can be contacted by phone at +1 216 696 5600 and by fax at +1 216 696 5864

CLEVELAND…One Hot City!

The City of Cleveland is located in the mid-west and northern region of the United States of America in the State of Ohio. Just to the east of Illinois and west of Pennsylvania, and nestled in the Heartland of America, the city welcomes visitors to the north coast shores of the Great Lake Erie.

Cleveland is a city on the move…an incredible combination of old-world tradition and the utmost in modern-day entertainment and sophistication. It's a city of fine arts and fun attractions. It's a shopping metropolis and a sports mania. From dining to dancing, it's a multi-cultural feast and the Rock and Roll capital of the world offering a musical spin on humanity that's exciting, friendly and warm.

While visiting the city one can hop on the Waterfront Line and ride it to North Coast Harbor where you can check out the world's Rock and Roll Hall of Fame and Museum and the Great Lakes Science Center. If sports are on your mind, then you can head over to Jacob's Field for a Cleveland Indian's baseball game.

If live entertainment is more your game, take in a performance at Playhouse Square or experience some of the world's finest cultural institutions at University Circle, including the Cleveland Orchestra and the Cleveland Museum of Art. Walk on the wild side at the Rainforest at Cleveland Metroparks Zoo or head to the "FLATS" Entertainment District for an evening of fun and frolic.

No matter your taste or your choice, Cleveland's diversity, beauty and charm will warm your stay and certainly welcome your visit.

Directions to Cleveland, Ohio, USA
Cleveland, Ohio can be reached as follows:

- ***By air***: Fly to **Cleveland Hopkins International Airport** (10 miles southwest of downtown Cleveland) with more than 350 arriving and departing flights daily.
  To downtown Cleveland from **Cleveland Hopkins International Airport** the following services are available:
  – *Private Taxi*: Approximate fare: $22.00, Travel time: 15 minutes
  – *Car Rental*: Approximate fare: Based upon availability, Travel time: 15 minutes
  – *Limousine Service*: $80.00 based upon availability, Travel time: 15 minutes
  – *Shuttle Service*: Fare: $9.00 Travel time: 15 minutes
  – *Rapid Transit (RTA) Service*: Fare: $1.50 each way. Exact change is required.
  Directions: Take RTA to the Tower City Exit. The Renaissance hotel is attached to Tower City Entrance located in Public Square. Rapid Transit trains run every 12 minutes. Travel time: 25 minutes

- ***By train***: **AMTRAK** station is located one-mile from the Renaissance hotel.
  Directions to Hotel: Take East 9th Street to St. Clair Street. Make a left onto St. Clair. Proceed on St. Clair until you come to West 3rd. The Renaissance hotel is located on the corner of West 3rd.

- ***By car***: **South of Cleveland, Ohio**: Take I-71 N to East 9th Street Exit. Get off at exit and continue on East 9th Street. Make a left onto St. Clair Street. Proceed on St. Clair to West 3rd. The Renaissance hotel is located on the corner of West 3rd.
  East of Cleveland, Ohio: Take Ohio Turnpike (I-76W) to (I-80W) until Exit 11. Proceed on I-77 N to East 9th Street Exit. Get off at exit and continue on East 9th Street. Make a left onto St. Clair Street. Proceed on St. Clair to West 3rd. The Renaissance hotel is located on the corner of West 3rd .
  West of Cleveland, Ohio: Take the Ohio Turnpike (I-80E) until Exit 10. Proceed on I-71 N to East 9th Street Exit. Get off at exit and continue on East 9th Street. Make a left onto St. Clair Street. Proceed on St. Clair to West 3rd. The Renaissance hotel is located on the corner of West 3rd .

Car rental is not recommended since most attractions in Cleveland are within walking distance or a short cab ride from the hotel.

Maps of flying times from Cleveland to other U.S. major cities, driving times and distances from Cleveland to other U.S. major cities, and a map of downtown Cleveland is located at: ***www.travelcleveland.com*** *under the section titled How to Get There/Maps.*

Sixth Ka-Band Utilization Conference

May 31 – June 2, 2000 Cleveland, Ohio, USA

Registration Form

Family name..... First name .....……..

Company.....

Address.....

City.....……..... Zip Code..... Country.....

Phone..... Fax.....

E-mail.....…

Accompanied by.....…….

REGISTRATION FEES (and payment received)

Before April 30, 2000 Lit. 1.100.000

After April 30, 2000 Lit. 1.300.000

Payment:

The payment (**in Italian Lire only**) can be made by:

❑ **Bank cheque,** payable to Istituto Internazionale delle Comunicazioni

❑ **Bank transfer**, *free of bank charges*, payable to:

Istituto Internazionale delle Comunicazioni
Account No. 10543/80
Banca CARIGE, Sede Centrale,

Bank codes: ABI 06175-4, CAB 01400-1, CIN T
Via Cassa di Risparmio 15, 16123 GENOVA, Italy
(C*opy of the bank transfer to be mailed with this Form*)

❑ **Credit card:** ❑ VISA ❑ MasterCard ❑ Eurocard ***(no American Express)***

No. | | | | | | | | | | | | | | | |

Cardholder name.....

Card expiration date ..... Card holder birth date ……..

Signature .....… Date ……..

Please fill in and return this Form as soon as possible to:

STITUTO INTERNAZIONALE DELLE COMUNICAZIONI
Via Pertinace - Villa Piaggio
16125 GENOVA, Italy
Phone: + 39 010 2722383, Fax: + 39 010 2722183
E-mail: iic.istcomge@interbusiness.it

Sixth Ka-Band Utilization Conference

May 31 – June 2, 2000 Cleveland, Ohio, USA

Hotel Booking Form

Deadline: May 1, 2000

Family name..... First name.....
Company.....
Address.....
City..... Zip code..... Country.....
Phone..... Fax..... E-mail.....
Arrival date ..... **Departure date** ..... **Total night (s)** .....

Renaissance Hotel (site of the Conference)

(Check accommodation desired)

Deluxe One Bed/Two bed	❑ $ 135.00	(Italian Lire approx. 248.000)
Club Floor One Bed/Two Bed	❑ $ 165.00	(Italian Lire approx. 303.000)
Deluxe One Bedroom Suite	❑ $ 199.00	(Italian Lire approx. 366.000)

The rates are per room, per night. Taxes: 14.5 %.

A limited number of rooms are available at US government rates to those who qualify.
All reservations for arrival after 4:00 pm must be accompanied by a first night deposit with credit card. Hotel will not hold any reservation after 4:00 pm unless secured by the deposit.

❑ American Express ❑ MasterCard ❑ VISA ❑ Diners' Club

No. | | | | | | | | | | | | | | | |

Cardholder name.....

Card expiration date ..... Cardholder birth date.....

Date ..... Signature.....

This Form will be faxed (+1 216 696 5864) directly to the Renaissance Hotel not later than May 1, 2000

Renaissance Cleveland Hotel
24 Public Square
CLEVELAND, Ohio 44113
Phone +1 216 696 5600 – Fax +1 216 696 5864
www.renaissancehotel.com

Southern Exposure

Felix A. Miranda
Electron Division Technology Branch
Communications Technology Division

Recently, Felix Miranda, from the Electron Division Technology Branch at NASA Glenn Research Center had the opportunity to spend the 1998-1999 academic year at the University of Puerto Rico-Humacao Campus (UPRH), under the NASA Administrator's Fellowship Program (NAFP). The program is designed to enhance the professional development of NASA employees and the science and engineering faculty of Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribal Colleges. This program provides the opportunity to not only teach and conduct research at UPRH, but also assists NASA in its research and development mission.

Miranda spent his first semester in URPH's Department of Physics and Electronics, where he developed and taught a senior level course on Microwave Applications of High Temperature Superconducting (HTS) Thin Films. Furthermore, he taught Quantum Mechanics and served on a steering committee where he developed a Master of Science degree program in Material Sciences.

Responding to the UPR science policy and goals of strengthening research in the area of material sciences, Miranda co-organized a scientific workshop on Ferroelectric Materials, held at the Copa Marina Hotel and Resort in Guánica, P.R., where he initiated collaborations between the Arecibo Observatory, NASA Glenn, and UPRH to develop sensitive cryoreceivers for radioastronomy and satellite communications. As a community service, Miranda collaborated with the Puerto Rico NASA Space Grant Consortium and the Department of Communications at UPRH to develop a series of radiobriefings on space exploration, astronomy, and other space sciences endeavors. Overall, the main goal was to provide the general public with reliable information in these areas.

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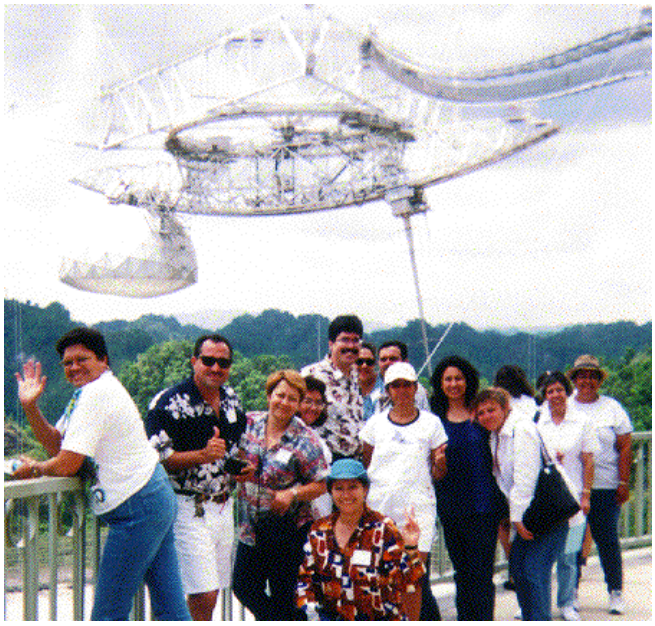

Workshop attendees and Felix Miranda (center of photo).

Regarding K-12 education outreach, Miranda led a workshop on Satellite Communications held at UPR-Mayagüez. Nearly 175 K-12 teachers participated in the one-day even where a dialogue with the Puerto Rico NASA Space Grant Consortium to create a Sub-Regional Teacher's Resource Center in Humacao was initiated. Currently there is only one of these centers, located in Mayagüez, in Puerto Rico. Encouraging students to participate in NASA programs resulted in three students being selected—2 of them accepted—to participate in the 1999 Lewis Educational and Research Collaborative Internship Program where Miranda served as a mentor and advisor.

An exciting aspect of the educational outreach efforts by Miranda was visiting schools across the island to discuss NASA-related subjects, student programs and careers. Nearly 500 K-12 students were contacted during these visits.

In conclusion, this was a rewarding experience both professionally and personally for Miranda. Not only did he have the opportunity to share NASA's goals and programs with the faculty and students at UPRH, but with the K-12 teachers and students at large.

For more information please e-mail us at:
spacecom@grc.nasa.gov
and refer to Article: 2399-08

A "WARM-ing" Hello In An Isolated Town

Janice L. Zarrelli
ADF Corporation
Space Communications Office

Godfrey Anzic
Applied RF Technology Branch
Communications Technology Division

South of the equator, located at 64^{o} 46' South / 64^{o} 5' West, lies a remote US scientific outpost called Palmer Station, Antarctica. Approximately 45 people live there during the summer months and as few as 16 people during the winter. Through the months of June to December, the sun is above the horizon only fifteen minutes each day. Frigid weather is quite common and travel may be life threatening. Furthermore, only two large multipurpose buildings exist where laboratories and recreational facilities are housed.

This past August, Art Anzic and Al Tucholski of NASA Glenn Research Center assembled a small VHF satellite ground terminal at Camp Pristava in Harpersfield, Ohio, to communicate via a Glenn managed, ATS-3 communications satellite with a group of scientists at Palmer Station, Antarctica.

Art Anzic and Al Tucholski.

Camp Pristava, a one week youth camp, sponsored by the Slovenian language schools of St. Vitus' and St. Mary's parishes of Cleveland, Ohio, provided forty-five children, between the ages of 9 and 13, the opportunity to interact and learn about Antarctica in a distance learning environment.

A visual and caring message warms the heart.

Due to geographic location of Palmer Station, medical assistance and facilities are very limited and consist of one physician and a small clinic. Having the opportunity to not only communicate verbally over the satellite, but also visually over the Internet, the children of Camp Pristava were hoping they would have the opportunity to comfort a seriously ill physician who was located at the US South Pole research base, about 1700 miles from Palmer Station. Since the ATS-3 satellite position at the time only allowed contacts with Palmer Station, the children were able to communicate with the Palmer scientists and ask them many interesting questions. The dialogue session lasted for about one and a half hours.

The children made a big, poster size "Get Well" card for the ill South Pole physician. Several digital photos were taken and sent to the Palmer Station staff and the South Pole physician via the Internet. Not only were the children fascinated by seeing their own pictures on the web site, but the ill physician had fast and easy access to the same pictures and could interact with the children by another telecommunications technology: E-mail.

Overall, Camp Pristava proved to be a great success. Not only was communicating via satellite an interactive learning tool for children to verbally dialogue, but it allowed them to see and be seen via Internet—at Palmer Station, Antarctica, a remote place on Earth only seen by a few!

For more information please e-mail us at:
spacecom@grc.nasa.gov
and refer to Article: 2399-09

Successful Transition of ACTS Into Inclined Orbit

Betty J. Waszil
ACTS Experiments
Space Communications Office

After five years of operating in a geo stationary orbit, the North/South station-keeping of ACTS was discontinued after July, 1998. Inclined orbit operations officially started one month later when the spacecraft started drifting daily north and south of the 0.05 degree box at 100 degrees West Longitude where its position had previously been maintained. Operating in an inclined orbit allowed fuel to be conserved and consequently operations to be extended. One North/South station-keeping maneuver consumes as much propellant (hydrazine) as 3.5 years of East/West station-keeping maneuvers. Issues that had to be addressed before inclined orbit operations could begin ranged from analysis of the ability of the ACTS spacecraft to operate properly to impacts on network performance and hardware and software changes required of the various ground stations. All issues were successfully addressed which allowed users to continue using ACTS in the new mode of operations.

The initial and most significant question that had to be answered was "would the spacecraft be able to maintain the precise pointing of the many spot beams?"

The initial and most significant question that had to be answered was would the spacecraft be able to maintain the precise pointing of the many spot beams. In 1997 Lockheed Martin completed a software simulation for controlling ACTS attitude position in an inclined orbit configuration.

Simulated were key elements that required the ability to reprogram the on-board attitude processor, and incrementally move the pitch-momentum wheel axis. The approach was further verified by operating the software patches on the spacecraft. The software was loaded into the off-line (redundant) attitude-control computer and the active (but not enabled) control outputs were monitored.

Final verification for I/O capability was met in late 1997 in an end-to-end test by delaying a North/South maneuver on the spacecraft and observing performance of the attitude control system for a thirty-three day interval, with the I/O software patches operating on-line, controlling the spacecraft. The redundant, attitude-control computer was loaded with normal software and ready to be switched on-line in short-notice, if needed. The I/O mode of operation was successfully validated by this test.

No other spacecraft subsystems needed modification for I/O operations. However, the ground operations became more involved with frequent command files required to update ephemeris and control movement of the pitch axis momentum wheel, but this did not impact transponder programming or operations.

The NASA Ground Station (NGS) hardware and software did not require upgrades for I/O, as COMSAT determined that the system would perform properly for the proposed inclined orbit operations. The ACTS Master Control Station (MCS) hardware and software were determined to be compliant for the first 20 months. Twenty months into I/O the relative motion between the spacecraft and the ground station would become large enough to impact T1-VSAT operations a few hours each day. At eight months into I/O the MCS software began generating unexpected nuisance alarms that were difficult to suppress. They were the result of several modules in the operations software (over a hundred thousand lines of code) that were detecting what was programmed to flag as drifting oscillators, but in reality was a frequency shift due to Doppler. No corrective action was required other than to ignore these daily alarms.

The ACTS Experiments Office led the task of upgrading the fleet of 25 ground stations in the ACTS network. Only the NGS and Link Evaluation Terminal (LET) had tracking ability. The tight station-keeping characteristics of ACTS prior to I/O allowed the LET antenna to be locked down nearly all the time, and the NGS tracking was only enabled for brief intervals. Tracking hardware was designed in-house for all of NASA's Earth stations; the T1 Very Small Aperture Terminals (T1-VSAT), the Ultra Small Aperture Terminals (USAT), and the High Data Rate (HDR) Terminals.

The pointing accuracy needed for the smaller beam width Ka-Band antennas could not be satisfied with commercial mounts that tracked wireless resolution over a wider range, horizon to horizon, instead of the limited motion ACTS needed for the North/South motion of only 2-degrees maximum. The in-house antenna design for the 1.2m (T1-VSAT), 0.6m (USAT), and 3.4m (HDR) provided excellent actuator resolution and accuracy for the motion required. All three terminals use the same commercial off-the-shelf antenna controller, but the approach for producing a feedback signal to the controller differs for each type of terminal.

The T1-VSAT and HDR fleet required software modifications to support the change in range to the satellite from the ground stations that would be experienced daily and impact certain acquisition and timing parameters in the TDMA network. The USAT fleet employs point-to-point or FDMA networks and did not require software upgrades.

The transition to I/O operations was accomplished on a schedule that provided seamless support to the ACTS experimenters during a planned phase down of the ACTS project.

For more information please e-mail us at:
spacecom@grc.nasa.gov
and refer to Article: 2399-10

Technical Papers and Presentations

Y. Jiang, R. Richmond, J. Baras, "Carrier Frequency Estimation of MPSK Modulated Signals", International Conference on Communications, Vancouver, Canada, June 6-10, 1999.

R. Poovendran, J. Baras, "Generation Group Public Keys with Dynamic Parameterization", Conference on the Mathematics of Public-Key Cryptography, The Fields Institute, Toronto, Ontario, Canada, June 12-17, 1999.

F. Van Keuls, C. Mueller, F. Miranda, R. Romanofsky, C. Canedy, S. Aggarwal, T. Venkatesan, R. Ramesh, J. Horwitz, W. Chang, W. Kim, "Room Temperature Thin Film BaxSr1-x TiO3 Ku-Band Coupled Microstrip Phase Shifters: Effects Of Film Thickness, Doping, Annealing and Substrate Choice", IEEE MTTS Conference, Anaheim, CA, June 13-19, 1999.

G. Ponchak, D. Akinwande, R. Ciocan, S. LeClair, M. Tabib-Azar, "Evanescent Microwave Proves Using Coplanar Waveguide and Striplines for Super-Resolution Imaging of Materials", IEEE MTT-S International Microwave Symposium, Anaheim, CA, June 13-19, 1999.

R. Romanofsky, "Room-Temperature Thin Film BaSrTiO Ku-Band-Coupled Microstrip Phase Shifters: Effects of Film Thickness, Doping, Annealing, and Substrate Choice", IEEE MTT-S International Microwave Symposium, Anaheim, CA, June 13-19, 1999.

K. Goverdhanam, R. Simons, L. Katehi, "Novel Three-Dimensional Vertical Interconnect Technology for Microwave and RF Applications", MTT-S International Microwave Symposium, Anaheim, California, June 13-19, 1999.

R. Kwok, S. Fiedziuszko, T. Schnabel, F. Miranda, N. Varaljay, C. Mueller, "Low-Profile Multilayer YBCO/MgO Filter Module", IEEE MTTS Conference, Anaheim, CA, June 13-19, 1999.

K. Goverdhanam, R. Simons, L. Katehi, "Novel Three-Dimensional Vertical Interconnect Technology for Microwave and RF Applications", MTT-S International Microwave Symposium, Anaheim, California, June 13-19, 1999.

R. Bauer, K. Bhasin, "Developing Advanced Internet Technologies and Applications Over ACTS", Fifth International Workshop on Satellite Communications in the Global Infrastructure (SCGII), Ottawa, Canada, June 15, 1999.

R. Kwok, E. Wintucky, G. Lesny, B. Vancil, "Recent Progress in the Development of a Low Cost Cathode/Electron Gun Assembly For Microwave and Millimeter Wave Device Applications", Tri-Service Vacuum Electronic Device Workshop, Bloomington, Indiana, June 16-17, 1999.

T. Elbatt, A. Ephremides, "Frequency Reuse Impact on the Optimum Channel Allocation for a Hybrid Mobile System", International Mobile Satellite Conference '99, Ottawa, Canada, June 16-18, 1999.

D. Robinson, V. Konangi, T. Wallett, "Performance of Duplex Communications Between a LEO Satellite and Terrestrial Location Using a GEO Constellation", International Mobile Satellite Conference '99, Ottawa, Canada, June 16-18, 1999.

K. Vaden, "Three-Dimensional Modeling of Multistage Depressed Collectors", IEEE International Conference on Plasma Science, Monterey, CA, June 20-24, 1999.

I. Krainsky, "The Angular Distribution of Elastically Scattered Electrons, Its Modeling and Computed Effect on Collector Performance", IEEE International Conference on Plasma Science, Monterey, CA, June 20-24, 1999.

C. Kory, "Three-Dimensional Simulations of Electron Beams Focused by Periodic Permanent Magnets", IEEE International Conference on Plasma Science, Monterey, CA, June 20-24, 1999.

R. Acosta, "Overcoming The Challenges of Rain Attenuation for next generation Ku, Ka and V band Systems,"Next Generation Broadband Satellite Systems, Tower Thistle Hotel, London, June 23 -24, 1999.

R. Poovendran. P. Keleher. J. Baras, "A Decision-Process Analysis of Implicit Coscheduling", 11th ACM Symposium on Parallel Algorithms and Architectures, Saint-Malo, France, June 27-30, 1999.

R. Simons, "A Millimeter-Wave Cavity-Backed Suspended-Substrate Stripline Antenna", IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Orlando, FL, July 11-16, 1999.

R. Lee, R. Simons, "Design of Broadband Vertical Transmissions for Tapered Slot Antennas", IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Orlando, FL, July 11-16, 1999.

R. Simons, "A Millimeter-Wave Cavity-Backed Suspended-Substrate Stripline Antenna", IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Orlando, FL, July 11-16, 1999.

Space Communications...

...Contacts.

A. Zaman, R. Simons, R. Lee, “Proximity-Coupled Dual-Polarized Patch Antenna”, IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Orlando, FL, July 11-16, 1999.

R. Lee, R. Simons, “Design of Broadband Vertical Transmissions for Tapered Slot Antennas”, IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Orlando, FL, July 11-16, 1999.

C. Emrich and R. Acosta, “Narrow angle diversity research using ACTS Ka band signal with two USAT ground station,” IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Orlando Florida, July 11-16, 1999.

S. Johnson and R. Acosta, “Propagation models comparison with measurments taken in a tropical rain zone using the ACTS system,” IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Orlando Florida, July 11-16, 1999.

B. Zaman, R. Simons, R. Lee, “Proximity-Coupled Dual-Polarized Patch Antenna”, IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Orlando, FL, July 11-16, 1999.

C. Zaman, R. Simons, R. Lee, “Proximity-Coupled Dual-Polarized Patch Antenna”, IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Orlando, FL, July 11-16, 1999.

A. Zaman, R. Lee, R. Simons, “Proximity-Coupled Dual-Polarized Patch Antenna”,IEEE AP-S International Symposium and USNC/URSI National Radio ScienceMeeting, Orlando, Florida, July 11-16, 1999.

R. Lee, R. Simons, “Design of Broadband Vertical Transitions for Tapered Slot Antennas”, IEEE AP-S International Symposium and USNC/URSI National Radio ScienceMeeting, Orlando, Florida, July 11-16, 1999.

R. Acosta, “A Wet antenna model for correcting Ka band propagation measurements,” IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Orlando Florida, July 11-16, 1999.

C. Cox and R. Acosta, “A Comparison of methods for minimizing or compensating for rain fade at Ka band,” IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Orlando Florida, July 11-16, 1999.

W. Ivancic, D. Shell, “Technologies & Services to Enable Voice Over IP”, Satellites and the Internet ’99, Arlington, VA, July 22, 1999.

M. Allman, “TCP Byte Counting Refinements”, ACM Computer Communications Review, July 23, 1999.

W. Eddy, M. Allman, “Advantages of Parallel Processing and the Effects of Communications Time”, NASA Glenn Research Center, August, 1999.

R. Acosta, “Multibeam Antenna Technology,” 2nd Annual International Symposium on Advanced Radio Technologies, US Dept. of Commerce Laboratories, Boulder, CO, September 8-10, 1999.

R. Bauer, “Developing Advanced Networking Technologies And Applications Over ACTS”, International Conference on Advanced Radio Technologies, Boulder, CO, September 8-10, 1999.

K. Bhasin, “Internet Technologies for Space-Based Communications: State of the Art and Challenges”, Space Technology Conference Exposition, Albuquerque, New Mexico, September 28-30, 1999.

J. Warner, K. Bhasin, J. Sroga, G. Silverman, D. Enlow, T. Nast, B. Williams, R. Mansour, G. Thomson, C. Wilder, “The Role of HTS in Future Communications Satellites”, Space Technology Conference Exposition, Albuquerque, New Mexico, September 28-30, 1999.

R. Rhinehart, W. Ivancic, T. Tanger, C. Cronon, D. Lee, D. Kifer, “Modem Characterization Through a Wideband, Hard-Limited Ka-Band Satellite Channel”, 5th Ka-Band Utilization Conference”, Taorimina, Italy, October 18-20, 1999.

J. D. Warner, R. Romanofsky, F. Miranda, “Evaluation of Six-Pole YBCO HTS Filters For K-Band Cryoreceiver Applications”, 2nd Annual Microelectronics Reliability and Qualification Workshop, Pasadena, CA, October 26-27, 1999.

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ACTS Conference 2000

The ACTS mission, after nearly 7 years of operations, will finally come to a conclusion in June 2000! To commemorate the end of this successful program and to report the concluding results and lessons-learned from the program, a one-day conference is being planned by NASA Glenn Research Center as part of the 6th Ka-Band Utilization Conference next year. Mark your calendars now and watch for more upcoming details!

May 31, 2000
Renaissance Hotel
Cleveland, Ohio

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